A Distributed E2E Recovery mechanism for MPLS networks

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**Objective:**
Establishment of an E2E LSP backup tunnel.

**Scope of application:**
Per-domain or/and inter-domain node/link/SRLG failure.
Two procedures of backup path establishment are applied:

- **FRPC (Forward Recursive PCE Computation):**
  - the backup path process reaches a domain to which the original working LSP tunnel belongs to.

- **BRPC (Backward Recursive PCE Computation):**
  - the backup tunnel process reaches a domain to which the original working LSP tunnel does not belong to.

BRPC is based on a tree named DBPT (Downstream Backup Path Tree):

- A DBPT tree is MP2P (Multi-point to point) TE LSP tree returned by a PCE to the upstream PCE.
- A DBPT tree defines, per-ingress-node, a set of relative paths that can be used to bypass a failure.
- A DBPT is established at working LSP Tunnel setup.

FRPC is based on locally defined databases: Internal and external LSP DataBases.
• PCE-to-PCE communication: exchange DBPT, requests/responses of establishing LSP backup tunnels.
  • Based on PCEP protocol.
  • Extension of the PCEP protocol on inter-domain scope (by Kumaki and Murai, *PCEP extensions for a BGP/MPLS IP-VPN*)

• Discovery of neighbor PCE: extension of protocols IGP and BGP (RFC 5088 and RFC 5089)
Let $p$ be the probability of finding an Internal LSP that joins the original working tunnel. Let $q$ be the probability of finding an External LSP that joins the original working tunnel.

The probability of finding a backup tunnel is:

Using FRPC:

$$
Pr_t = \alpha \sum_{i=0}^{k} \beta^i \beta^{n-1} \quad \forall k < n
$$

$Pr_0 = p$

Using BRPC:

$$
Pr_t = \beta Pr_{t-1}
$$

$Pr_0 = p$

Where:

$$
\alpha = p + q(1 - p)
$$

$$
\beta = (1 - p)(1 - q)
$$

- The probability of finding a backup tunnel is greater with FRPC than with BRPC.
- FRPC ensures less E2E-recovery time than BRPC.
- BRPC ensures less local resource-wasting than FRPC.

- BRPC procedure is based on the break-before-make model
  - connection is found before making any resources reservation.
Performances evaluation

1) Recovery time, Pckt Loss and Pckt Disorder rates Comparaison

• IBLBT takes more time before rerouting activation
  • many updates should be applied on local LFIB within gateways and proxies.
• E2E recovery mechanism takes over 47 ms
  • This is due to notification and activation mechanism toward PSL and PML.
• The BGP recovery model remains although clearly divergent
  • recovery time ratio reaches over 53% (Proposed mechanism vs BGP)
• Similarly, the new mechanism ensures lower packet loss rate
  • it can reach a factor of 3.94 lower than the packet loss rate ensured by BGP.
• Packet disorder ensured by the BGP model can reach over a factor of 5.26 more than proposed mechanism.

<table>
<thead>
<tr>
<th></th>
<th>BGP recovery model</th>
<th>E2E Recovery Mechanism</th>
<th>IBLBT</th>
<th>Proposed mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time recovery</td>
<td>64 s</td>
<td>47.28 ms</td>
<td>31.34 ms</td>
<td>29.67 ms</td>
</tr>
<tr>
<td>Pckt Loss rate</td>
<td>47%</td>
<td>22%</td>
<td>13.5%</td>
<td>15.9%</td>
</tr>
<tr>
<td>Pckt Disorder</td>
<td>66.7%</td>
<td>36.18%</td>
<td>9.87%</td>
<td>7.67%</td>
</tr>
</tbody>
</table>

Figure: Comparison between various approaches for inter domain recovery

2) Pckt re-order and Pckt drop Evaluation
Conclusion

• The problem of End to End recovery in MPLS-based multi-domains networks.

• A mechanism for failure handling and traffic protection despite heterogeneity and autonomy of crossed areas.

• An alternative call between two path computation procedures
  • BRPC (Backward Recursive PCE Computation)
  • FRPC (Forward Recursive PCE Computation).

Main drawback : convergence of searching process?
What is the probability to reach a domain to which the original working tunnel belongs to!!!
Thank You

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